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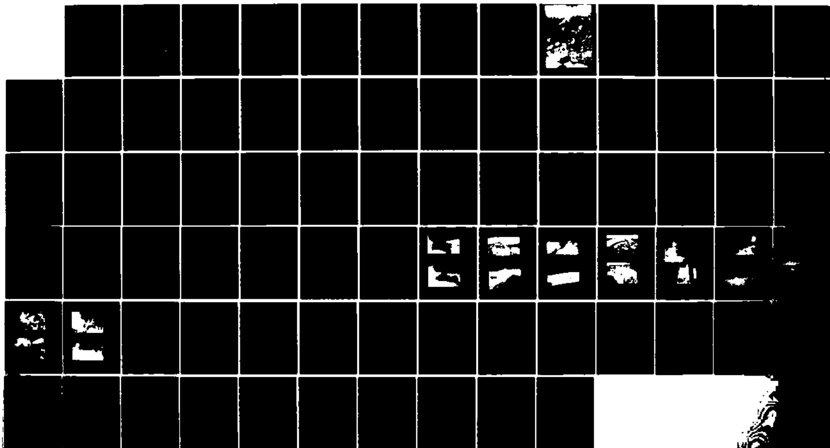

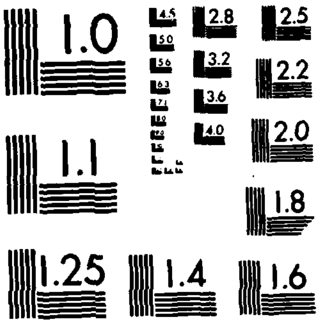

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AD-A156 434

MERRIMACK RIVER BASIN

DEERING, NEW HAMPSHIRE

DEERING RESERVOIR DAM

NH 00282

NHWRB NO. 62.05

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS. 02154

NOVEMBER 1978

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		6. PERFORMING ORG. REPORT NUMBER
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18. SUPPLEMENTARY NOTES

Cover program reads: Phase I Inspection Report, National Dam Inspection Program; however, the official title of the program is: National Program for Inspection of Non-Federal Dams; use cover date for date of report.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

DAMS, INSPECTION, DAM SAFETY,

Merrimack River Basin
Deering , New Hampshire
Piscataquog River

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The dam is a 625 ft. long, 25 ft. high earth embankment dam. The inspection did not disclose any findings that indicate an immediate unsafe condition. The condition of the dam is good. The inspection revealed a right training wall which is badly cracked and in need of repair. Because the dam can pass 95% of the test flood without being overtopped, the spillway capacity is not considered to be seriously inadequate.

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DEERING RESERVOIR DAM

NH 00282

NHWRB 62.05

MERRIMACK RIVER BASIN
DEERING, NEW HAMPSHIRE

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

LETTER OF TRANSMITTAL

FROM THE CORPS OF ENGINEERS TO THE STATE

TO BE SUPPLIED BY THE CORPS OF ENGINEERS

NATIONAL DAM INSPECTION PROGRAM
PHASE I - INSPECTION REPORT
BRIEF ASSESSMENT

Identification No.:	00282
Name of Dam:	Deering Reservoir Dam
Town:	Deering
County and State:	Hillsboro, New Hampshire
Stream:	Piscataquog River
Date of Inspection:	August 15, 1978

Deering Reservoir Dam is a 625 foot long, 25 foot high earth embankment dam. A set of plans dated 1940 showing plan, elevation, typical sections and details as well as a set of construction specifications were available for this investigation. No construction data or design calculations were available.

The visual examination did not disclose any findings that indicate an immediate unsafe condition. The general condition of the dam is good. The inspection revealed a right training wall which is badly cracked and in need of repair, some surface erosion of the downstream face, inability to drain the reservoir due to blockage at the outlet structure and obstructions in the downstream channel.

Deering Reservoir Dam's spillway will not pass the required test flood. The dam's spillway capacity is approximately 95 percent of the test flood and consequently, the dam would be overtopped by approximately 0.15 feet under the test flood conditions. However, because the dam can pass 95 percent of the test flood without being overtopped, the spillway capacity is not considered to be seriously inadequate.

It is recommended that the owner engage a qualified engineer to design for the necessary repair of the badly cracked right training wall of the spillway and to evaluate further the potential for overtopping and the inadequacy of the spillway. It is also recommended that the owner repair and seed all surface erosion on the downstream face of the dam and provide for the removal of the fill placed in the river bed at the outlet structure.

The recommendations and remedial measures are described in Section 7 and should be addressed within two years after receipt of this Phase I - Inspection Report by the owner.

Gordon H. Slaney, Jr.

Gordon H. Slaney, Jr., P.E.
Project Engineer

Howard, Needles, Tammen & Bergendoff
Boston, Massachusetts

DEERING RESERVOIR DAM - Overview looking upstream

This Phase I Inspection Report on Dam has been reviewed by the undersigned Review Board members. In our opinion, the reported findings, conclusions, and recommendations are consistent with the Recommended Guidelines for Safety Inspection of Dams, and with good engineering judgment and practice, and is hereby submitted for approval.

CHARLES G. TIERSCH, Chairman
Chief, Foundation and Materials Branch
Engineering Division

FRED J. RAVENS, Jr., Member
Chief, Design Branch
Engineering Division

SAUL COOPER, Member
Chief, Water Control Branch
Engineering Division

APPROVAL RECOMMENDED:

JOE B. FRYAR
Chief, Engineering Division

THIS SHEET TO BE FURNISHED BY THE CORPS OF ENGINEERS

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there by any chance that unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test Flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aide in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

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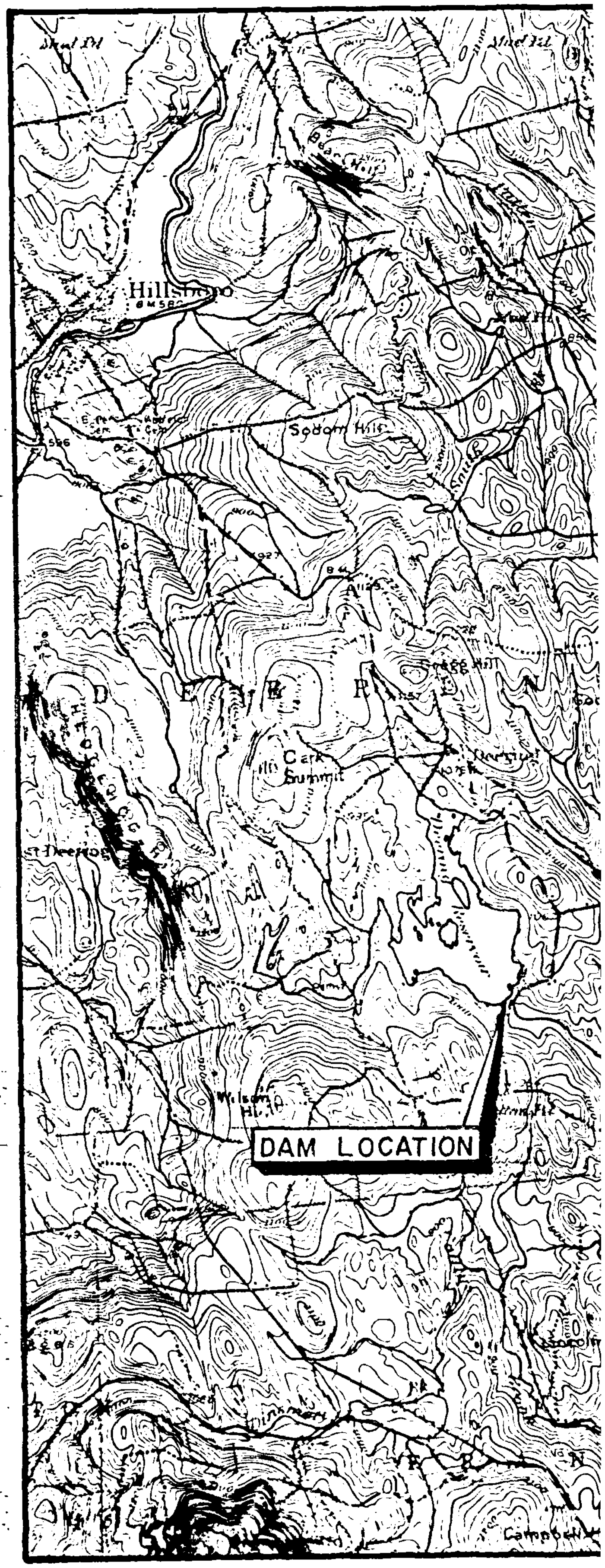
DAM LOCATION

NATIONAL DAM INSPECTION PROGRAM
PHASE I INSPECTION REPORT
DEERING RESERVOIR DAM

SECTION 1
PROJECT INFORMATION

1.1 General

a. Authority. Public Law 92-367, August 8, 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a National Program of Dam Inspection throughout the United States. The New England Division of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the New England Region. Howard, Needles, Tammen & Bergendoff has been retained by the New England Division to inspect and report on selected dams in the State of New Hampshire. Authorization and notice to proceed were issued to Howard, Needles, Tammen & Bergendoff under a letter of July 12, 1978 from John P. Chandler, Colonel, Corps of Engineers. Contract No. DACW33-78-C-0356 has been assigned by the Corps of Engineers for this work.

b. Purpose

(1) To perform technical inspection and evaluation of non-Federal dams to identify conditions which threaten the public safety and thus permit correction in a timely manner by non-Federal interests.

(2) To encourage and prepare the states to initiate quickly effective dam safety programs for non-Federal dams.

(3) To update, verify and complete the National Inventory of Dams.

1.2 Description of Project

a. Location. Deering Reservoir Dam is located in the Town of Deering, New Hampshire. Deering Reservoir forms the headwaters of the Piscataquog River. The Piscataquag River flows in a generally easterly direction for a distance of approximately 25 miles to its confluence with the Merrimack River in Manchester, New Hampshire. The dam is shown on U.S. G.S. Quadrangle, Hillsboro, New Hampshire, with coordinates approximately at N 43°03'10", W 71°50'40", Hillsboro County, New Hampshire. Deering Reservoir Dam's location is shown on the Location Map immediately preceding this page.

b. Description of Dam and Appurtenances. Deering Reservoir Dam is an earthfill structure approximately 25 feet high and 625 feet long from the right abutment to the spillway structure. The upstream face has a slope of approximately 2½ feet vertical to 1 foot horizontal (2½:1) with 1.5 foot riprap placed to within 2 feet of the dam crest. The downstream face has approximately a 2:1 slope for the first 5 feet from the top and approximately a 2½:1 slope below this point to the toe of the dam. The appurtenant works consist of a concrete spillway, spillway channel and outlet works consisting of sluiceway with stoplogs and a reinforced concrete drain pipe. The sluiceway and spillway are located at the left abutment of the dam. The outlet works gate and conduit are located in the original Piscataquog River bed. Figure 1, located in Appendix B, shows the plan of the dam, spillway and outlet works. Photographs of each structure are shown in Appendix C.

c. Size Classification. Intermediate (hydraulic height - 21 feet, storage - 4,985 acre-feet) based on storage (≥1,000 to 50,000 acre-feet) as given in the Recommended Guidelines for Safety Inspection of Dams.

d. Hazard Classification. The dam's potential for damage rates it as a significant hazard classification. A major breach could result in the loss of a few lives, damage to the roadway immediately downstream and damage to approximately four houses.

e. Ownership. The present dam is believed to have been constructed in 1940 by the State of New Hampshire Water Resources Board and has been owned by the Water Resources Board since that time.

f. Operator. This dam is maintained and operated by the State of New Hampshire Water Resources Board, 37 Pleasant Street, Concord, New Hampshire 03301. Chairman of the Water Resources Board is Mr. George M. McGee, Sr.; Mr. Vernon Knowlton is Chief Engineer. Telephone No. (603)271-1110.

g. Purpose of Dam. The purpose of this dam is primarily to form a recreational pool with some flood control benefits which are described in Section 4, Operational Procedures.

h. Design and Construction History. The drawings for this dam were prepared by the New Hampshire Water Resources Board and are dated 1940. Construction was started and completed in that general time period. (Original dam owned by the New Hampshire Public Service Company had been destroyed during 1938 storm). The drawings and the specifications for this dam are available at the New Hampshire Water Resources Board. No in-depth design or construction data were disclosed for this dam.

i. Normal Operational Procedure. The Deering Reservoir Dam is used primarily for the retention of Deering Reservoir which is used for recreational purposes. A secondary purpose of the dam and its resulting reservoir area is for control of winter and early spring runoff. The normal operational procedure for this dam is to remove the stop logs in the sluiceway sometime in the month of October or November of each year thus lowering the reservoir level approximately 5 feet below the dam's spillway elevation. The resultant available storage is used to control snow melt and heavy runoff during the winter and spring months. In May of each year, the stop logs are then reinserted into the sluiceway to at least the elevation of the spillway, thus returning the reservoir level to spillway level for summertime recreational purposes.

1.3 Pertinent Data

a. Drainage Area. The drainage area above the Deering Reservoir Dam consists of approximately 4.5 square miles of rolling, heavily wooded hills. The periphery of Deering Reservoir is comprised of wooded area with some residences located near the reservoir.

The reservoir area itself contains some small islands but is devoid of dead trees protruding through the surface or other visible impediments to navigation. There are some private docks or piers noted along the area inspected.

The watershed supporting Deering Reservoir is forested rolling terrain with very few flat areas. All areas in the basin are well vegetated with a few paved roads and housing. Topographic elevation in the watershed ranges from about 1,520 to 920 feet MSL.

There are several relatively small tributaries which drain into the reservoir. The longest of these tributaries is approximately 1.5 miles long with a vertical drop over its length of over 300 feet.

b. Discharge at Dam Site

(1) The outlet works for the Deering Reservoir Dam consists of a 5 foot wide sluiceway and a 24 inch diameter outlet drain pipe. The reservoir behind the dam can be lowered 5 feet below the spillway crest elevation (921) by the removal of the wooden stop logs in the sluiceway. The 24 inch outlet drain pipe was designed to allow dewatering of the reservoir from the bottom of the sluiceway elevation (916) to the original river bed elevation (902).

(2) The maximum discharge at this dam site is unknown.

(3) The spillway capacity with a water surface at the top of the dam and assuming stop logs in sluiceway set at the same elevation as the permanent spillway crest is approximately 4,600 cfs at an elevation of 927.0.

(4) The spillway capacity with the water surface at the test flood elevation, again assuming the stop logs in the sluiceway are set at the same elevation as the permanent spillway crest is approximately 4,760 cfs at an elevation of approximately 927.15.

(5) The stoplog sluiceway capacity at normal pool elevation (921.0) is estimated to be 150 cfs upon removal of all stoplogs.

(6) The total spillway capacity at the test flood elevation of 927.15 is estimated to be 4,760 cfs.

(7) The total project discharge at the test flood elevation of 927.15 is estimated to be 4,860 cfs.

c. Elevation (feet above MSL) based on elevation of 921.0 shown on U.S.G.S. quad sheet assumed to be pool elevation at permanent spillway crest.

(1) Streambed at centerline of dam - 902.0±.

(2) Maximum tailwater - unknown.

(3) Upstream portal invert diversion tunnel - none.

(4) Recreation pool - 922.0.

(5) Full flood control pool (see Section 1.2.i) - 916.0.

(6) Spillway crest (permanent spillway) - 921.0.

(7) Design surcharge - unknown.

(8) Top dam - 927.0.

(9) Test flood surcharge - 927.15.

d. Reservoir (miles)

(1) Length of Maximum pool - 1.5.

(2) Length of Recreational pool - 1.5.

(3) Length of flood control pool - 1.2±.

e. Storage (acre-feet)

(1) Recreation pool - 3,400.

(2) Flood control pool (see Section 1.2.i)

(3) Spillway flood pool (at permanent spillway crest) - 3,100.

(4) Top of dam - 4,980.

(5) Test flood pool - 5,027.

f. Reservoir Surface (acres)

(1) Recreation pool - 314+.

(2) Flood control pool - ≮314.

(3) Spillway crest - 314.

(4) Test flood pool -

(5) Top dam -

Note: Surface areas used for these were same as at spillway crest.

g. Dam

(1) Type - earthen dam with concrete spillway.

(2) Length - 650± feet, overall.

(3) Height - 25 feet (maximum).

(4) Top width - 10 feet.

(5) Side slope - US = 2½:1; DS = 2:1 and 2½:1.

(6) Zoning - unknown.

(7) Impervious core - compacted earth (by specifications).

(8) Cutoff - concrete at sluiceway.

(9) Grout curtain - none.

(10) Other - none.

h. Diversion and Regulating Tunnel

See Section j below.

i. Spillway

(1) Type - concrete, curved with straight drop.

(2) Length of weir - 78.5 feet.

(3) Crest elevation - 921.0.

(4) Gates - stoplog sluiceway - 5 feet wide.

(5) U/S channel - none.

(6) Downstream channel - a 90 foot reach approximately 40 feet wide downstream of the spillway leads to a roadway bridge, again 40 feet wide. Below the bridge the downstream channel continues approximately 200 feet to the natural channel with overhanging trees.

j. Regulating Outlets. Regulating outlet consists of a 24 inch diameter reinforced concrete drain pipe at elevation 905.75 which was designed to discharge into the river bed directly below the dam. The pipe inlet is controlled by a manually operated wooden slide gate. The outlet to this drain conduit is buried, and complete discharge of the reservior is not possible under present conditions.

SECTION 2
ENGINEERING DATA

2.1 Design

A set of plans dated 1940 showing plan, elevation, typical sections and details along with a set of specifications are available at the State of New Hampshire Water Resources Board. No in-depth engineering calculations were found. A description of repairs which included the removal and replacement of 29 feet of the right abutment wall was also available. This data was dated 1963.

2.2 Construction

No construction records are available for use in evaluating the dam.

2.3 Operation

No engineering operational data were disclosed.

2.4 Evaluation

a. Availability. The Deering Reservoir Dam was designed by the New Hampshire Water Resources Board. Other than the plans and specifications described above, no additional engineering data was found to be available.

b. Adequacy. Available engineering data and drawings are considered adequate for a Phase I investigation.

c. Validity. The field investigation indicated that the external features of the Deering Reservoir Dam substantially agree with those shown on the furnished plans.

SECTION 3
VISUAL INSPECTION

3.1 Findings

a. General. The field inspection of Deering Reservoir Dam was made on August 15, 1978. The inspection team consisted of personnel from Howard, Needles, Tammen & Bergendoff and Geotechnical Engineers, Inc. A representative of the State of New Hampshire, Water Resources Board was also present during portions of the inspection. Inspection checklists, completed during the visual inspection are included in Appendix A. At the time of the inspection, the water level was approximately 2½ inches above the permanent spillway elevation, being approximately 7½ inches below the flashboard elevation. Water was passing over the spillway approximately ½ inch deep. The upstream face of the dam could only be inspected above this water level.

b. Dam. Visual inspection of the embankment indicated no signs of distress. Since completion of the present dam, debris has been dumped in the old river channel downstream of the dam and roadway at the toe of the dam. This debris has buried the outlet works of the 24-inch-diameter conduit. This filling of the river channel was reported to the Board of Selectmen of Deering by the New Hamshire Water Resources Board in 1965.

Upstream Slope

Only the upper 6 ft. of the upstream slope was visible at the time of inspection. Photos 3 and 4 show the slope, which is in good condition. In some areas excessive vegetation has grown in the riprap. Personnel from New Hampshire Water Resources Board were spraying to eradicate the vegetation the day of the dam inspection.

Crest

The crest of the dam has no pavement. No evidence of cracking or misalignment was observed.

Downstream Slope

The face of the entire downstream slope was traversed along two lines: (1) along the crest and (2) along the toe. In addition, the central section of the dam between Stations 4+00 and 6+50 was traversed at intermediate elevations.

The slope is in generally good condition. In some areas the turf and grass cover is not as dense as it should be, and there is some minor erosion of the slope due to trespassing on the slopes. This erosion can be seen in Photos 5 and 6. Near the right abutment there is an area of dense undergrowth and trees. In general, the trees are below the dam slope. Personnel from the New Hampshire Water Resources Board indicated that they had planned to clean this area of excessive growth.

No seepage or damp areas were observed along the toe of the dam.

c. Appurtenant Structures. Visual inspection of the spillway structure showed the concrete surface and the two construction joints to be in generally good condition. There is, however, some erosion of the concrete joints. Photo 9 shows the general view of the spillway structure, with details of joint deterioration being shown on Photo 11.

The right training wall of the spillway is badly cracked. The extent of the cracking can be seen in Photos 10, 11, 12 and 13. Construction plans indicate that the gravity training walls were built without reinforcing steel. Deteriorated concrete as disclosed by visual inspection, i.e. deep cracks and spalling, will be exposed to rapid deterioration which could eventually lead to the possible collapse of this wall. The integrity of this wall is important to the embankment for the following reasons:

1. Collapse of this wall would likely be followed by collapse of the fill immediately behind the wall, resulting in a shortened seepage path through and beneath the dam.

2. If collapse were to take place during periods of high flow, erosion would take place at the toe of the dam.

The wet area on the right training wall (Photo 12) at the wall and footing-stem intersection is believed to be from surface drainage. However, this cracked wall section is adjacent to the downstream side of the dam embankment and should be repaired.

The outlet works for Deering Reservoir, consisting of gate, 24 inch conduit and outlet headwall were not inspected as the gate structure was well below the water surface and the outlet headwall was buried by debris. The outlet works discharge

channel, located in the original river bed, has been filled in with what appears to be roadway waste material, boulders and tree stumps. This fill material extends approximately 90 feet downstream of the outlet structure. Photos 15 and 16 show the results of this filling in of the river channel.

Visual inspection of the spillway discharge channel showed it to be in generally good condition. Bed rock in the channel is in good condition with no evidence of loose rock. There are no overhanging trees that would appear to obstruct free flow of the channel discharge.

d. Reservoir Area. The reservoir slopes are generally covered with trees and brush. Cottages are scattered along the shoreline. The amount of siltation within the reservoir is unknown.

e. Downstream Channel. The downstream channel has a gravel bottom covered with many rocks and is heavily lined with trees, many overhanging the channel. There is one cottage immediately downstream on the right side. The channel leads to a large swampy area approximately 6000 feet downstream. Photos 17 and 18 show the general downstream conditions.

3.2 Evaluation

Visual examination indicates no immediate safety problem. The condition of the dam is generally good, however, the right training wall is badly cracked, and collapse of a portion of this wall would expose the embankment to sliding and erosion. This wall must be repaired. The inspection also revealed the following:

(a) Inability to drain the reservoir due to the filling of the river channel at the outlet works of the 24 inch diameter conduit.

(b) Minor erosion of the downstream face.

(c) Many overhanging trees on the downstream channel.

SECTION 4
OPERATIONAL PROCEDURES

4.1 Procedure

The Deering Reservoir Dam is used primarily for the retention of Deering Reservoir which is used for recreational purposes. A secondary purpose of the dam and its resulting reservoir area is for control of winter and early spring runoff. The normal operational procedure for this dam is to remove the stop logs in the sluiceway sometime in the month of October or November of each year thus lowering the reservoir level approximately   feet below the dam's spillway elevation. The resultant available storage is used to control snow melt and heavy runoff during the winter and spring months. In May of each year, the stop logs are then reinserted into the sluiceway to at least the elevation of the spillway, thus returning the reservoir level to spillway level for summertime recreational purposes.

4.2 Maintenance of Dam

This dam is visited by one of the State of New Hampshire, Water Resources Board's dam operators approximately once per week. During these visits water levels are recorded, grass is cut as necessary, painting is done as necessary and any major deficiencies that may be noted are reported to the Water Resources Board. Occasional clearing of the brush on the embankment is also scheduled on a need basis.

During 1963, repairs were made to the dam which included the removing and replacing of approximately 29 feet of the cracked section of the abutment wall and stop log slab. A new 15 foot cutoff wall was also constructed upstream of the stop log section, and a gravel and storm drain was built downstream of this cutoff wall to drain water away from the abutment wall.

4.3 Maintenance of Operating Facilities

As the outlet works are either below water (at the inlet) or buried beneath fill (at the outlet) no maintenance is performed on these facilities.

4.4 Description of Warning Systems

There are no warning systems in effect at this facility.

4.5 Evaluation

The current operation and maintenance procedures for Deering Reservoir Dam are inadequate to insure that all problems encountered can be remedied within a reasonable period of time. The owner should establish a written operation and maintenance procedure as well as establishing a warning system to follow in event of floodflow conditions or imminent dam failure.

HYDROLOG

5.1 Evaluation of Fea

a. General. The
dam approximately 25 f
right abutment to the
works consist of an 78
stop log sluiceway sec
conduit. The dam is l
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primarily used for rec
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b. Design Data.
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d. Visual Observ
portion of the project
time of the inspection

e. Overtopping P
operational informatio
was performed using da
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the Probable Maximum F
curves issued by the C
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Following the guidance
Storage on Maximum Pr
discharge of 4,560 cf
the top of the dam is
of the test flood dis
in the dam being over

f. Dam Failure
dam at maximum pool w

Guidance for Estimating Downstream Dam Failure Hydrographs issued by the Corps of Engineers. The analysis covered the reach extending from the dam to Weare Reservoir. Failure of Deering Reservoir Dam at maximum pool would probably result in a downstream channel depth of approximately 15.0 feet between the dam and the swampy area approximately 6,000 feet downstream. An increase in water depth of this magnitude would probably result in the loss of less than 10 lives, sever the road immediately downstream of the dam and might destroy one or two houses. This volume of water entering the swampy area would probably create a depth of about 10 feet. Between this swampy area and Weare Reservoir, one or two additional homes could possibly be damaged as well as the possibility of damage to two roadways.

SECTION 6
STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations. The visual inspection did not disclose any immediate stability problems with the embankment. However, the right training wall of the spillway is badly cracked, and collapse of this wall would endanger the integrity of the embankment.

b. Design and Construction Data. Design drawings and construction specifications exist and indicate that the embankment consists of two zones; a wide compacted impervious upstream zone protected by riprap and a compacted downstream pervious zone which incorporates a substantial rock toe. A one-foot-thick filter has been placed between the downstream zone and the rock toe. The upstream and downstream slopes are 1 vertical: 2 horizontal, flattening to 1 vertical: 2.5 horizontal at the normal pool elevation.

c. Operating Records. No operating records were made available.

d. Post-Construction Changes. In 1963, repairs were made to the existing dam consisting of removing and replacing approximately 29 feet of a cracked section of the right training wall and the stop log slab. A new 15 foot cutoff wall was also constructed upstream of the stop log section and a gravel and stone drain was built downstream of this cutoff wall to drain water away from the training wall.

Since construction of this dam in 1940 and prior to 1965, the Town of Deering, in an attempt to improve roadway conditions in the vicinity of the dam, hauled in stumps, boulders and gravel to widen the roadway section. This resulted in the outlet structure to the reservoir drain being blocked. Initially, this blockage extended approximately 18 feet downstream of the drain outlet. Since that time, it appears that this type of material has continued to be disposed of in the river bed such that the fill section presently extends about 90 feet beyond the drain outlet.

e. Seismic Stability. The dam is located in Seismic Zone 2, and in accordance with recommended Phase I guidelines does not warrant seismic analysis.

SECTION 7
ASSESSMENT, RECOMMENDATIONS AND REMEDIAL MEASURES

7.1 Dam Assessment

a. Condition. The visual examination did not disclose any findings that indicate an immediate unsafe condition. The condition of the dam is generally good. The inspection revealed the following:

(1) The right training wall is badly cracked and in need of repair.

(2) Inability to drain the reservoir because of blockage at the outlet structure.

(3) Some surface erosion of the downstream face is evident.

(4) Downstream channel obstruction caused by overhanging trees.

(5) Inadequacy of the spillway.

The hydraulic analysis reveals that the dam connot pass the required test flood. However, as it can pass approximately 78 percent of the test flood without being overtopped, the spillway capacity is not considered seriously inadequate.

b. Adequacy of Information. The information made available by the New Hampshire Water Resources Board was totally adequate for a Phase I level of investigation.

C. Urgency. This dam is in generally good condition. The recommendation and remedial measures described in 7.2 and 7.3 should be implemented within two years after receipt of this Phase I Inspection Report by the owner.

d. Need of Additional Investigation. The findings of the visual inspection do not warrant additional investigation. However, repair of the spillway training wall should be undertaken, which work should include determining why the wall cracked and appropriate measures taken to prevent a similar concurrence to the repaired wall.

7.2 Recommendations

It is recommended that the owner engage a qualified engineer to design for the necessary repair of the badly

cracked right training wall of the spillway and to evaluate further the potential for overtopping and the inadequacy of the spillway.

7.3 Remedial Measures

(a) Repair and seed all surface erosion on the downstream face of the dam.

(b) Arrange to have the fill placed in the river bed removed.

(c) The tree and brush growth in the downstream channel should be removed and kept free in the future.

(d) Develop a written operational procedure to follow in the event of flood flow conditions or imminent dam failure.

(e) Continue the technical inspection program on a bi-annual basis.

7.4 Alternatives

There are no practical alternatives to the recommendations of Section 7.2 and 7.3 except that on an interim basis the owner may consider operating the reservoir at a lower level throughout the year so as to provide more storage for extreme flood events.

APPENDIX A

VISUAL CHECK LIST WITH COMMENTS

VISUAL INSPECTION CHECK LIST
PARTY ORGANIZATION

PROJECT Deering Reservoir

DATE August 15, 1978

TIME 10 a.m.

WEATHER Sunny and Warm

W.S. ELEV. 921.1 U.S. 903± DN.S

PARTY:

1. Lyall Milligan N.H.W.R.B.
2. Gordon Slaney, HNTB
3. Stan Mazur, HNTB
4. D. P. LaGatta, GEI
5.
6.
7.
8.
9.
10.

PROJECT FEATURE	INSPECTED BY	REMARKS
1. Dam	Dan LaGatta	
2. Spillway, Sluiceway	Stan Mazur	
3. Outlet Works/Downstream Channel	Gordon Slaney	
4.		
5.		
6.		
7.		
8.		
9.		
10.		

PERIODIC INSPECTION CHECK LIST

PROJECT Deering Reservoir

DATE August 15, 1978

PROJECT FEATURE Dam Embankment

NAME D. P. LaGatta

DISCIPLINE Geotechnical Eningeers Inc.

NAME

AREA EVALUATED	CONDITION
DAM EMBANKMENT	
Crest Elevation	927.0
Current Pool Elevation	921.2
Maximum Impoundment to Date	Unknown.
Surface Cracks	None visible.
Pavement Condition	No pavement.
Movement or Settlement of Crest	None visible.
Lateral Movement	None visible.
Vertical Alignment	No misalignment observed.
Horizontal Alignment	
Condition at Abutment and at Concrete Structures	Right training wall of spillway badly cracked. See Section 3.1.c.
Indications of Movement of Structural Items on Slopes	None observed.
Trespassing on Slopes	There has been minor erosion on d.s. slope due to trespassing.
Sloughing or Erosion of Slopes or Abutments	
Rock Slope Protection - Riprap Failures	Riprap in good condition with minor growth which is removed yearly.
Unusual Movement or Cracking at or near Toes	
Unusual Embankment or Downstream Seepage	None observed.
Piping or Boils	None observed.
Foundation Drainage Features	Design dwgs. indicate rock toe drain.
Toe Drains	None visible.
Instrumentation System	None.

PERIODIC INSPECTION CHECK LIST

PROJECT Deering Reservoir | DATE August 15, 1978

PROJECT FEATURE Intake Structure/Channel | NAME D. P. LaGatta

DISCIPLINE Hydraulics Engr./Geotechnical Engr. | NAME G. Slaney

AREA EVALUATED	CONDITION
<u>OUTLET WORKS - INTAKE CHANNEL AND INTAKE STRUCTURE</u>	None.
a. Approach Channel	
Slope Conditions	
Bottom Conditions	
Rock Slides or Falls	
Log Boom	
Debris	
Condition of Concrete Lining	
Drains or Weep Holes	
b. Intake Structure	Intake structure below water surface and inaccessible for inspection.
Condition of Concrete	
Stop Logs and Slots	

PERIODIC INSPECTION CHECK LIST

PROJECT Deering Reservoir

DATE August 15, 1978

PROJECT FEATURE Control Tower

NAME

DISCIPLINE Structural Engineer

NAME S. Mazur

AREA EVALUATED	CONDITION
OUTLET WORKS - CONTROL TOWER	This facility has no tower.
a. Concrete and Structural	
General Condition	
Condition of Joints	
Spalling	
Visible Reinforcing	
Rusting or Staining of Concrete	
Any Seepage or Efflorescence	
Joint Alignment	
Unusual Seepage or Leaks in Gate Chamber	
Cracks	
Rusting or Corrosion of Steel	
b. Mechanical and Electrical	
Air Vents	
Float Wells	
Crane Hoist	
Elevator	
Hydraulic System	
Service Gates	
Emergency Gates	
Lightning Protection System	
Emergency Power System	
Wiring and Lighting System	

PERIODIC INSPECTION CHECK LIST

PROJECT Deering Reservoir DATE August 15, 1978

PROJECT FEATURE Conduit NAME S. Mazur

DISCIPLINE Hydraulic Engineer/Structural Engineer NAME G. Slaney

AREA EVALUATED	CONDITION
<u>OUTLET WORKS - TRANSITION AND CONDUIT</u>	24 inch RCP drain conduit was inaccessible for inspection as intake was below water and outlet has been covered with borrow and waste material.
General Condition of Concrete	
Rust or Staining on Concrete	
Spalling	
Erosion or Cavitation	
Cracking	
Alignment of Monoliths	
Alignment of Joints	
Numbering of Monoliths	

PERIODIC INSPECTION CHECK LIST

PROJECT Deering Reservoir

DATE August 15, 1978

PROJECT FEATURE Outlet Structure/Channel

NAME D. P. LaGatta

DISCIPLINE Geotechnical Engr./Hydraulic Engr.

NAME G. Slaney

AREA EVALUATED	CONDITION
OUTLET WORKS - OUTLET STRUCTURE AND OUTLET CHANNEL	Outlet structure not examined as it has been filled over with borrow and waste material during apparent roadway construction. Three sink holes were observed in the vicinity of outlet structure.
General Condition of Concrete	
Rust or Staining	
Spalling	
Erosion or Cavitation	
Visible Reinforcing	
Any Seepage or Efflorescence	
Condition at Joints	
Drain Holes	
Channel	
Loose Rock or Trees Overhanging Channel	
Condition of Discharge Channel	Good. See text for discussion of dumped fill blocking conduit.

PERIODIC INSPECTION CHECK LIST

PROJECT Deering Reservoir — DATE August 15, 1978

PROJECT FEATURE Spillway/Discharge Channel — NAME D. P. LaGatta

DISCIPLINE Structural Engr./Geotechnical Engr. — NAME S. Mazur

AREA EVALUATED	CONDITION
OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS	
a. Approach Channel	
General Condition	Good.
Loose Rock Overhanding Channel	None.
Trees Overhanging Channel	None of significance.
Floor of Approach Channel	Good condition.
b. Weir and Training Walls	
General Condition of Concrete	Good - see text.
Rust or Staining	Some at drain holes.
Spalling	None.
Any Visible Reinforcing	None observed.
Any Seepage or Efflorescence	Seepage at bottom of right training wall about 25 feet donwstream of spillway.
Drain Holes	Drainage beneath wall, see text, Section 3.
c. Discharge Channel	
General Channel	Good.
Loose Rock Overhanging Channel	No loose rock.
Trees Overhanging Channel	None.
Floor of Channel	Bedrock - good condition.
Other Obstructions	Bridge.

PERIODIC INSPECTION CHECK LIST

PROJECT Deering Reservoir

DATE August 15, 1978

PROJECT FEATURE Service Bridge

NAME

DISCIPLINE

NAME

AREA EVALUATED	CONDITION
<u>OUTLET WORKS - SERVICE BRIDGE</u>	This facility has no service bridge.
a. Super Structure	
Bearings	
Anchor Bolts	
Bridge Seat	
Longitudinal Members	
Under Side of Deck	
Secondary Bracing	
Deck	
Drainage System	
Railings	
Expansion Joints	
Paint	
b. Abutment & Piers	
General Condition of Concrete	
Alignment of Abutment	
Approach to Bridge	
Condition of Seat & Backwall	

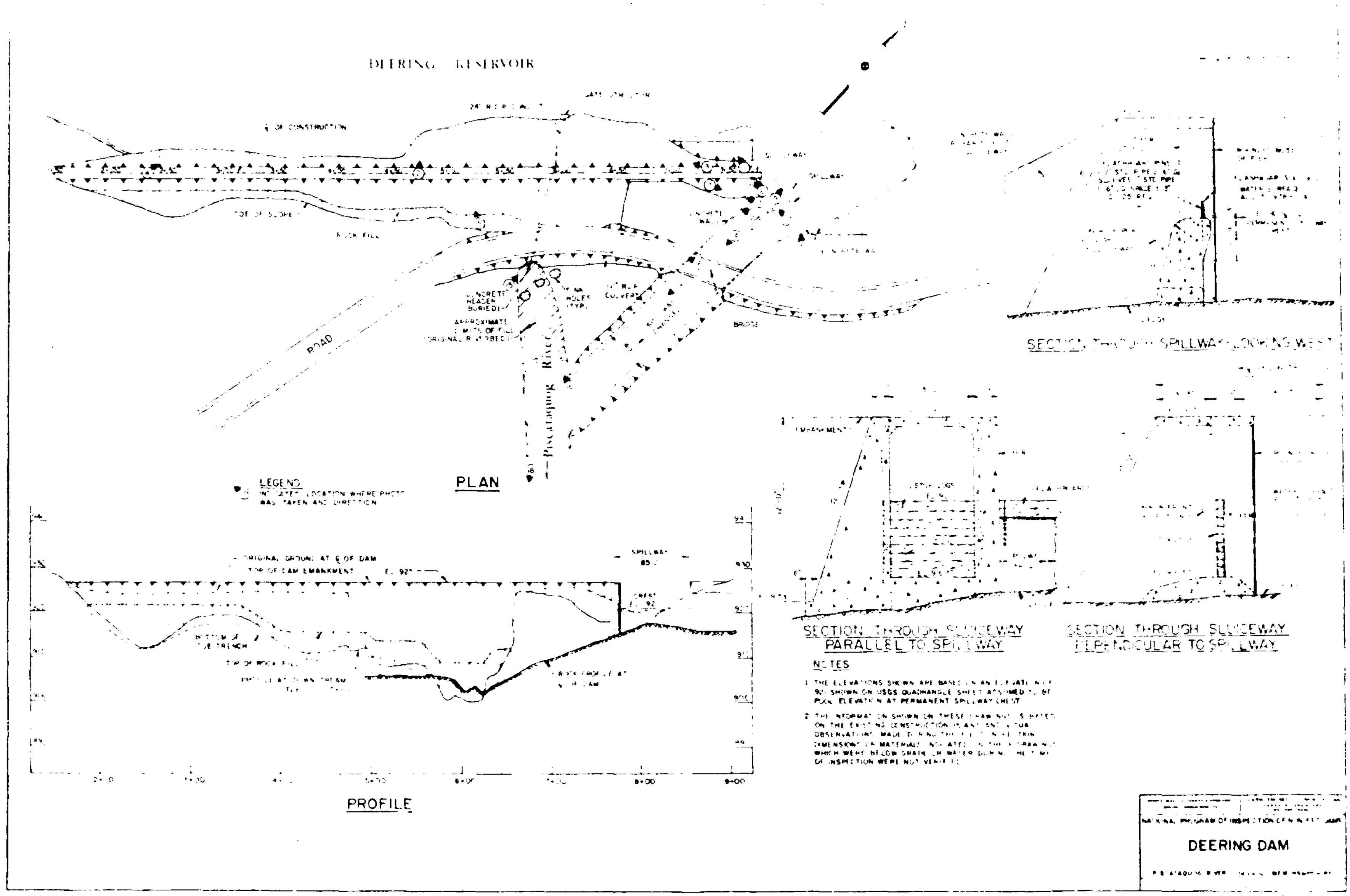
f. <u>Dam Failure</u>
dam at maximum pool w

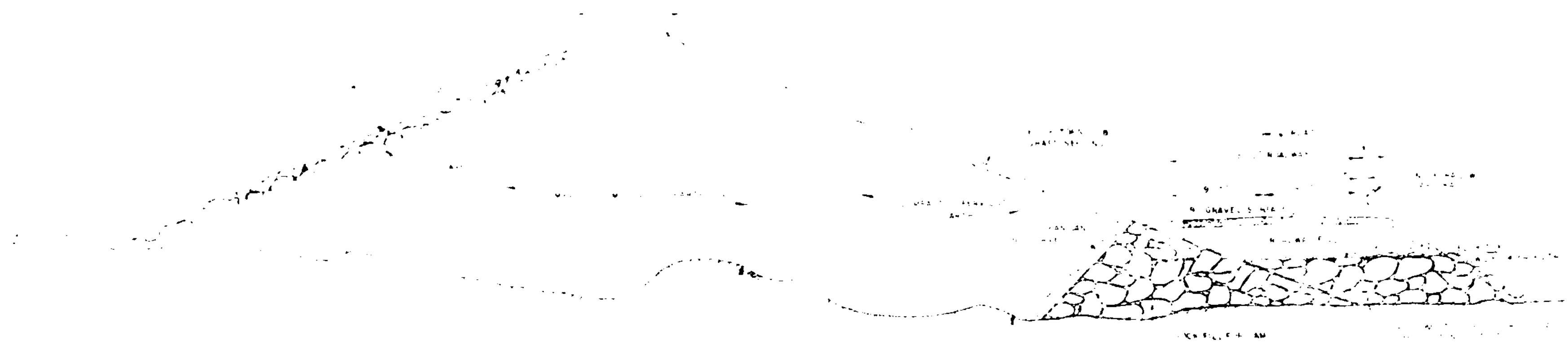
1. LIST OF DESIGN, C(
2. PAST INSPECTION R
3. PLANS AND DETAILS

AVAILABLE ENGINEERING DATA

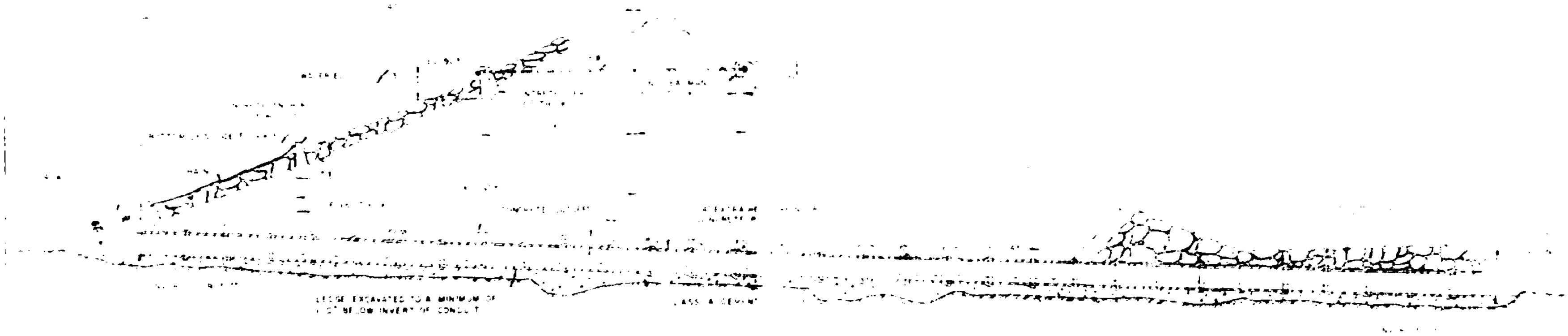
A set of plans dated 1940 showing plan, elevation, typical sections and details are available at the New Hampshire Water Resources Board, 37 Pleasant Street, Concord, New Hampshire 03301.

A set of construction specifications is also available at the New Hampshire Water Resources Board.


DEERING RESERVOIR
℄ OF CONSTRUCTION
TOE OF SLOPE
ROCK FILL
ROAD
CONCRETE HEADER BURIED
APPROXIMATE LIMITS OF FILL ORIGINAL RIVERBED
BRIDGE
Piscataquog River
SPILLWAY
PLAN
LEGEND
INDICATES LOCATION WHERE PHOTO WAS TAKEN AND DIRECTION
ORIGINAL GROUND AT ℄ OF DAM
TOP OF DAM EMBANKMENT
BOTTOM OF TIE TRENCH
TOP OF ROCK FILL
PROFILE
SECTION THROUGH SPILLWAY LOOKING WEST
EMBANKMENT
SECTION THROUGH SLUICEWAY PARALLEL TO SPILLWAY
SECTION THROUGH SLUICEWAY PERPENDICULAR TO SPILLWAY
NOTES
1. THE ELEVATIONS SHOWN ARE BASED ON AN ELEVATION OF 921 SHOWN ON USGS QUADRANGLE SHEET ASSUMED TO BE POOL ELEVATION AT PERMANENT SPILLWAY CREST
2. THE INFORMATION SHOWN ON THESE DRAWINGS IS BASED ON THE EXISTING CONSTRUCTION AND ON VISUAL OBSERVATIONS MADE DURING THE FIELD INSPECTION. DIMENSIONS OR MATERIALS INDICATED ON THESE DRAWINGS WHICH WERE BELOW GRADE OR WATER DURING THE TIME OF INSPECTION WERE NOT VERIFIED.
NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS
DEERING DAM
PISCATAQUOG RIVER
NEW HAMPSHIRE



SECTION OF DAM AT STA 6+00



SECTION ON ℄ OF CONDUIT

DEERING DAM

PAST INSPECTION REPORTS

62.05

M E M O R A N D U M

FROM: Francis C. Moore
Civil Engineer

November 16, 1965

RE: Blocking of Pond Drain Outlet at Deering Reservoir

TO: Leonard R. Frost
Water Resources Engineer

This morning I investigated the blocking of the outlet drain at Deering Reservoir. The town road agent apparently decided that the old river channel was a good place to dump large boulders, stumps, logs and earth to widen the inside of the curve in the road.

The blockage extends about eighteen feet downstream from the outlet at river channel elevation and about ten feet downstream at the top of slope. The channel is filled in parallel to the road with the top of slope moved about twenty feet further away from the road than originally constructed.

I left a pole with orange tape on it at the approximate location of the outlet of the pond drain.

As this blockage prevents any possible draining of Deering Reservoir under present conditions, I suggest that the Town of Deering (or those placing this fill) be required to uncover the outlet and provide an adequate channel from it. This will probably require a power shovel as there are boulders in the fill up to 2 cubic yards.

Francis C. Moore
Francis C. Moore
Civil Engineer

FCM/sam

APPENDIX C

PHOTOGRAPHS

FOR LOCATION OF PHOTOS, SEE FIGURE 1
LOCATED IN APPENDIX B

Photo No. 1 - General view of reservoir from left abutment.

Photo No. 2 - General view of reservoir from center of dam.

Photo No. 3 - General view of dam from left abutment.

Photo No. 4 - General view of dam from right abutment.

Photo No. 5 - Erosion of downstream slope.

Photo No. 6 - Downstream slope showing erosion areas.

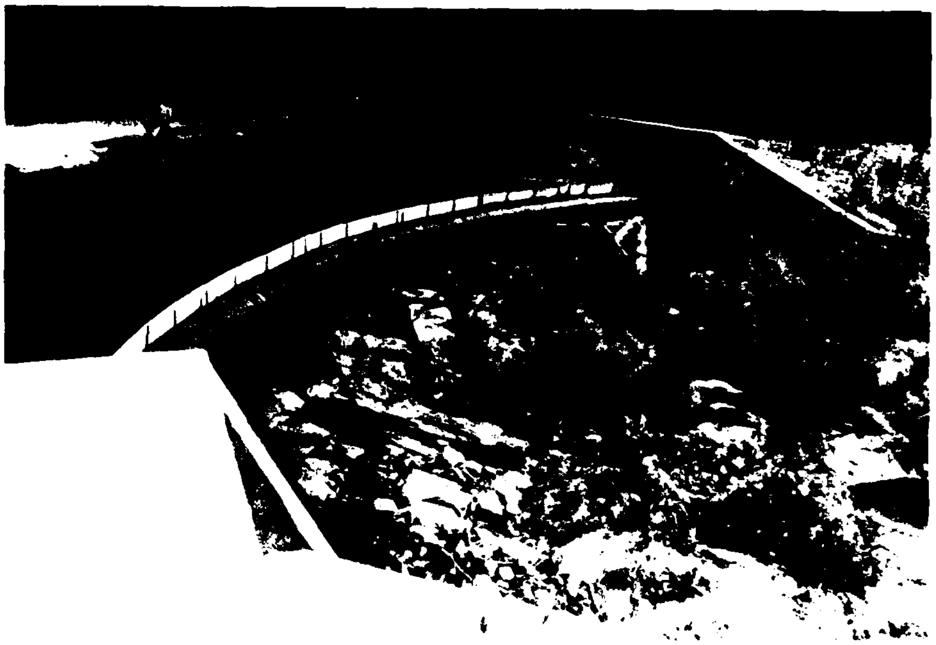


Photo No. 7 - General view of spillway structure, looking toward left abutment.

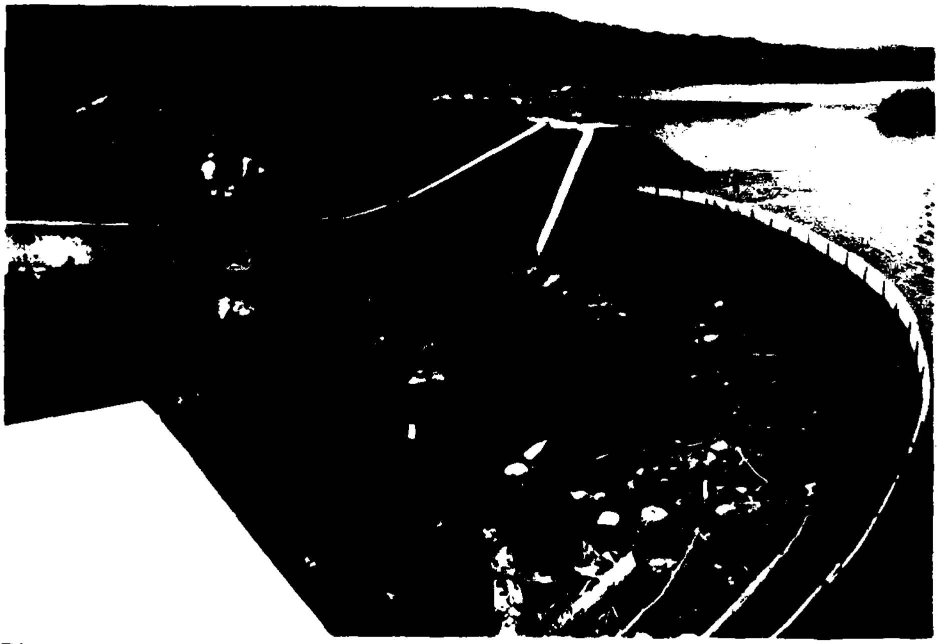


Photo No. 8 - Spillway structure and sluiceway structures, looking toward right abutment.

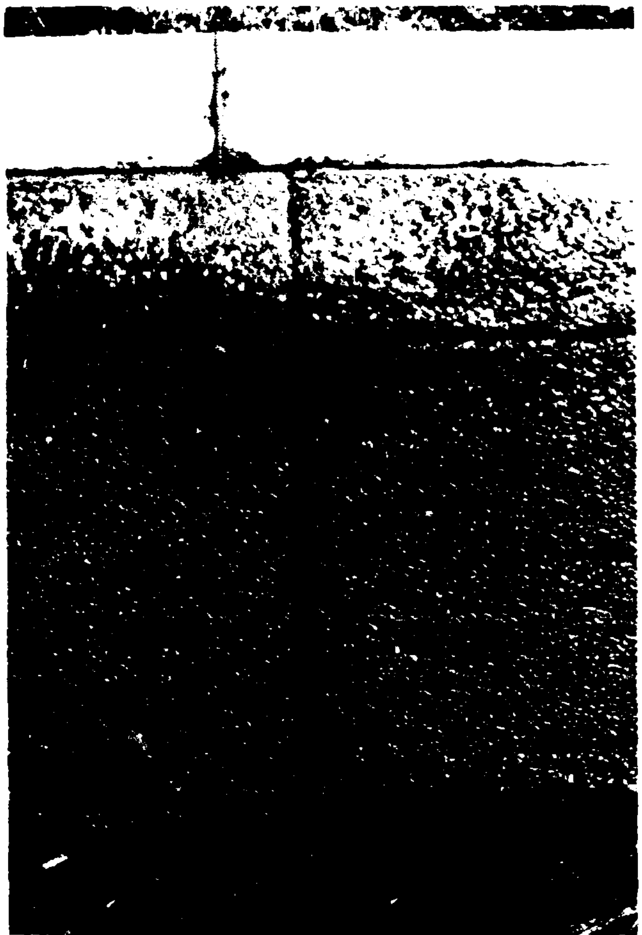


Photo No. 9 - Spillway structure joint detail.

Photo No. 10 - Sluiceway structure, conditions and details.

Photo No. 11 - Right training wall of sluiceway.

Photo No. 12 - Right training wall, deterioration of concrete (cracks, spalling and seepage).

Photo No. 13 - Right training wall, close up of expansion join.

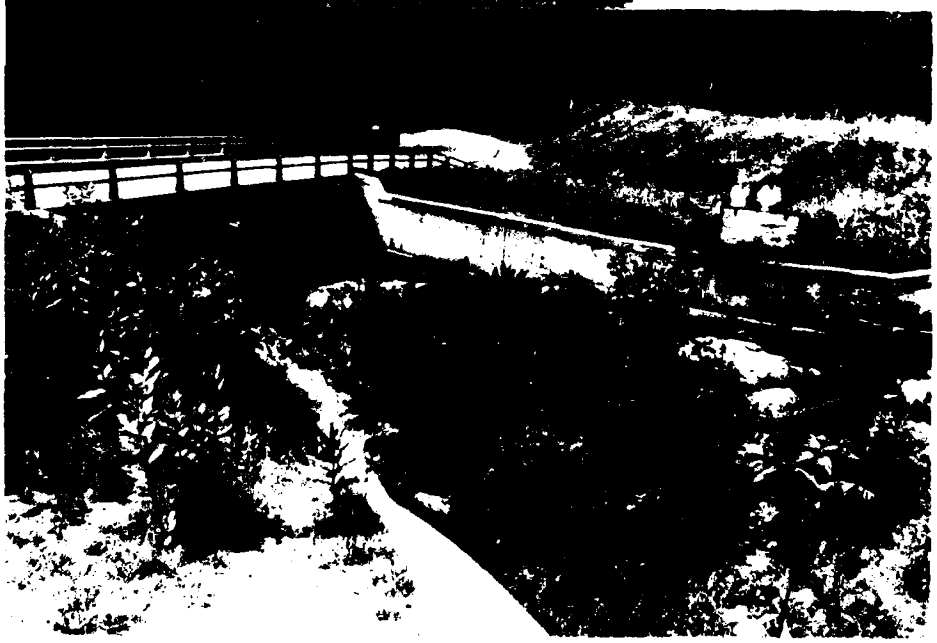


Photo 14 - General view of spillway channel and roadway bridge.

Photo No. 15 - Sink
cond
in h

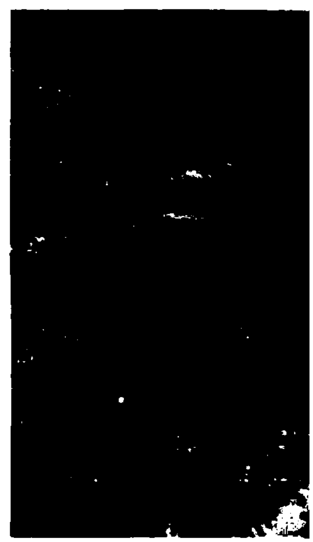


Photo No. 16 - Down
down

Photo No. 17 - General view of downstream channel.

Photo No. 18 - General view of downstream area.

APPENDIX D

HYDROLOGIC AND HYDRAULIC COMPUTATIONS

HNTB HOWARD NEEDLES TAMMEN & BERGENDOFF	Made by KMD	Date 9/26/78	Job No. 5625-11-02
	Checked by HM	Date 10/02/78	Sheet No. 1
DEERING DAM - DEERING, N.H.			

BASIC DATA:

Drainage area = 4.5 square miles (N.H. Water Control Comm. data verified)
Based on Corps of Engineers guidelines:
SIZE CLASSIFICATION: INTERMEDIATE (storage ≥ 1000 and < 50,000 a-ft)
HAZARD POTENTIAL CLASSIFICATION: SIGNIFICANT

For dams with an Intermediate size classification and Significant hazard potential a test flood equal to the PMF is indicated in the Corps guidelines.

ELEVATION VS. WATER SURFACE AREA VS. VOLUME

Conditions	Elevation* (ft.)	Surface area** (acres)	Reservoir volume (acre-ft.)
1. Crest of dam embankment	103.0	314	4984
2. Max. flood height based on N.H. Water Control Comm. data	100.0	314	4042
3. Top of flashboards	98.0	314	3414
4. Permanent spillway	97.0	314	3100
5. Normal drawdown (elev. of bot. of stoplog sluiceway)	92.4	250	1800
6. Maximum drawdown	84.0		
7. Original pond	81.0	100	

* elevations in above table are referenced to local datum and are as provided in N.H. Water Control Commission data

** surface area above permanent spillway was assumed to be the same as the permanent spillway surface area of 314 acres as per contract modification of dam inspection guidelines.

Note: It is assumed that the normal pool elevation of 921 (as shown on the USGS quad sheet) is equal to the permanent spillway crest elevation of 97.0 (local datum).

SPILLWAY DATA

Permanent spillway length : 78.5 ft.
Stoplog sluiceway (acts as spillway) : 5.0 ft.
Total effective length of spillway : 83.5 ft.

type: concrete wall
structural height : 5 feet ±

DAM DATA

type: earth w/ impervious core
crest elev: 103.0 local datum
length: 650 ft.
highest depth of embankment: 25 ft.

SPILLWAY CAPACITY DETERMINATION

To determine the spillway capacity it is assumed that flashboards along the permanent spillway will have washed away and the stoplog sluiceway will be set at elev. 97.0, the elevation of the permanent spillway.

maximum elevation before dam overtopped = 103.0

Head = 103.0 - 97.0 = 6.0 ft. (max. before dam overtopped)

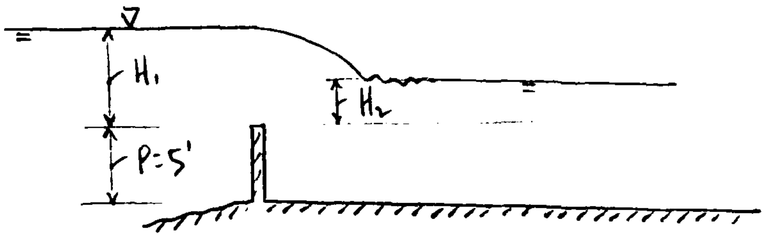
Since the height of the conc. spillway is so low, it is necessary to investigate downstream conditions to determine if the spillway will be submerged by a downstream tailwater. Look at normal depth (d_n) for various flows in downstream channel.

SPILLWAY CAPACITY DETERMINATION (cont.)

Channel data:
width = 40'
manning's coef. = 0.03 (rock channel)
slope = 0.03 ft./ft.

Compute d_n for the following flows in downstream channel

Q (cfs)	d_n (ft.)	remarks
2,000	3.05	
4,000	4.75	
6,000	6.20	spillway submerged
8,000	7.51	" "
10,000	8.75	" "



Submerged Weir

For submerged weir:

$$\frac{Q}{Q_1} = \left[1 - \left(\frac{H_2}{H_1}\right)^n\right]^{0.385}$$

reference: Std. Handbook for Civil Engineers, Merritt

where: Q = discharge for submerged conditions, cfs
Q_1 = free discharge, cfs
n = exponent in free discharge equation, $Q_1 = C L H_1^{3/2}$
$C = (3.27 + 0.4 \frac{H_1}{P})$ for $0.5 \le \frac{H_1}{P} \le 5$ (Rehbock's equation)
P = height of weir

SPILLWAY CAPACITY DETERMINATION (cont.)

To compute the maximum spillway capacity without overtopping the dam (elev. 103.0) $H_1 = 103.0 - 97.0 = 6.0$ ft.

then $Q = Q_1 \left[1 - \left(\frac{H_2}{H_1}\right)^{3/2}\right]^{0.385}$

or $Q = C L H_1^{3/2} \left[1 - \left(\frac{H_2}{H_1}\right)^{3/2}\right]^{0.385}$

H_2 and Q are unknowns, therefore use trial & error procedure. 1st Trial assume $H_2 = 2.5$ ft. for $H_1 = 6.0$ ft.

Trial No.	H_1 (feet)	H_2 (feet) "Assumed"	Q (cfs)	d_n, normal depth (feet)	H_2 (assumed) vs. H_2 (computed)	status
1	6.0	2.5	4080	4.82	$2.5 \neq 0$	N.G.
2	6.0	0.0	4602	5.21	$0 \neq .21$	N.G.
3	6.0	0.2	4591	5.20	$0.2 = 0.2$	O.K.

therefore based on above trial & error process the maximum spillway capacity = 4591 cfs (say 4600 cfs)

this flow creates a downstream flow depth d_n of 5.2 ft. which submerges the spillway by 0.2 ft.

Maximum spillway capacity before dam over-topped ≅ 4600 cfs

EFFECT OF SURCHARGE STORAGE ON MAX. PROBABLE DISCHARGE

Drainage area = 4.5 sq. miles
basin characteristics: rolling zone
Test flood = PMF (significant hazard + intermediate size)
using Corps of Engineers procedures;

Step 1 Determine peak inflow (Q_{p_1}) from Guide Curves

from Guide Curve for rolling terrain & d.a. = 4.5 sq. mi.
Max. prob. flood = 1880 cfs / sq. mi.

HNTB HOWARD NEEDLES TAMMEN & BERGENDOFF	Made by Vicky Hill	Date 9/26/78	Job No. 5678-11-02
	Checked by ...ll	Date 10/2/78	Sheet No. 5

For DEERING DAM

EFFECT OF SURCHARGE STORAGE (cont.)

then Q_{p_1} = 1880 cfs/sq. mile × 4.5 sq. miles = 8460 cfs

Step 2 Determine surcharge height to pass Q_{p_1}

the crest of the dam (at elevation 103.0) is assumed to act as a broad-crested weir. Accordingly:

$Q_c = CLH^{3/2}$ for $H < 1.5\,b$
$b = 10'$ = width of crest

where $C = 3.09$
L = length of crest = 650'
H = head over crest
Q_c = discharge over crest elev. 103, cfs

the spillway (elev. 97.0) is assumed to act as a submerged sharp-crested weir. Accordingly:

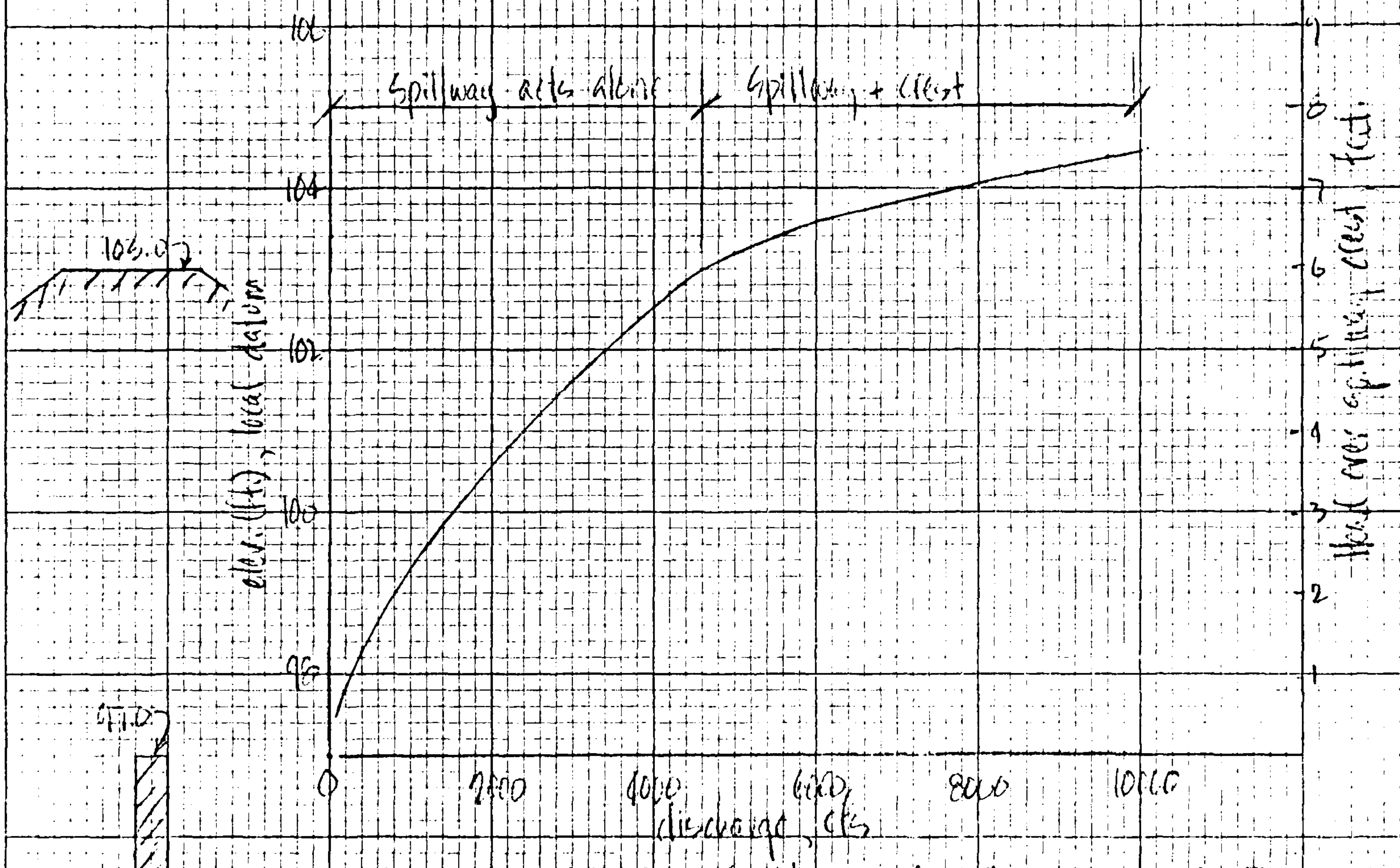
$$Q_s = CLH_1^{3/2}\left[1-\left(\frac{H_2}{H_1}\right)^{3/2}\right]^{0.385}$$

where $L = 83.5'$
C, H_1 & H_2 as previously defined on p.3
Q_s = discharge over spillway elev. 97.0, cfs

then $Q_{TOTAL} = Q_c + Q_s = Q_{over\ crest} + Q_{over\ spillway}$

Prepare stage-discharge table for different values of H = (water elev. − 103.0) for crest and corresponding H_1 = (water elev. − 97.0) for spillway.

Trial	W.S. elev.	Q_c (cfs)	Q_s (cfs)	H_2	Q_{TOTAL} (cfs)
1	103.0	0	4600	0.2	4600
2	103.5	710	5190	0.6	5900
3	104.0	2010	5800	1.0	7810
4	104.5	3690	6400	1.5	10090



STAGE-DISCHARGE CURVE - DEERING RESERVOIR

Fig. 1

EFFECT OF SURCHARGE STORAGE - (Cont.)

Step 2 (cont.)

from figure 1 determine elev. required to pass $Q_{p_1} = 8460$ cfs

elev = 104.2 for $Q_{p_1} = 8460$ cfs

a. the surcharge height will be 7.2 ft. above spillway crest to pass Q_{p_1}.

b. volume of surcharge storage ($STOR_1$) in inches of runoff:

$$STOR_1 = \frac{\text{volume of surcharge storage} \times 12 \text{ in/ft.}}{\text{drainage area}}$$

$$= \frac{314 \text{ acres} \times (104.2' - 97.0') \times 12''/\text{ft.}}{4.5 \text{ sq.mi.} \times 640 \text{ acres/sq.mi.}}$$

$STOR_1$ = 9.42 inches of runoff

c. compute $Q_{p_2} = Q_{p_1}\left(1 - \frac{STOR_1}{19}\right)$

$$= 8460\left(1 - \frac{9.42}{19}\right) = 4265 \text{ cfs}$$

Q_{p_2} = 4265 cfs

Step 3

a. determine surcharge height and $STOR_2$ to pass Q_{p_2}

surcharge height to pass Q_{p_2} = 102.7 (figure 1)

$$STOR_2 = \frac{314 \text{ acres} \times (102.7' - 97.0') \times 12''/\text{ft.}}{4.5 \text{ sq. miles} \times 640 \text{ acres/sq. mile}} = 7.46 \text{ inches}$$

$STOR_2$ = 7.46 inches of runoff

EFFECT OF SURCHARGE STORAGE (Cont.)

Step 3 (Cont.)

b. Average $STOR_1$ and $STOR_2$ and determine average surcharge and resulting peak outflow Q_{P_3}

$$\text{Average STOR} = \frac{STOR_1 + STOR_2}{2}$$

$$= \frac{9.42 + 7.46}{2} = 8.44 \text{ in}$$

$$STOR_{AVG} = 8.44 \text{ inches}$$

c $$Q_{P_3} = Q_{P_1} \times \left[1 - \frac{STOR_{AVG}}{19}\right] =$$

$$= 8{,}460 \text{ CFS} \times \left[1 - \frac{8.44}{19}\right] = 4{,}700 \text{ CFS}$$

STEP 4. A. Determine Surcharge Height for $Q_{P_3} = 4{,}700$ CFS

From Fig. 1 El. = 103.0'

B $$STOR_3 = \frac{314 \text{ Ac} \times [103.0' - 97.0'] \times 12''/\text{FT}}{4.5 \text{ S.M.} \times 640 \text{ A/SM}} = 7.85''$$

C. $$STOR_{Avg.} = \frac{8.44 + 7.85}{2} = 8.15''$$

D $$Q_{P_4} = 8{,}460 \text{ CFS} \times \left[1 - \frac{8.15''}{19''}\right] = 4{,}830 \text{ CFS}$$

STEP 5 A. Determine Surcharge Height for $Q_{P_4} = 4{,}830$ CFS

From Fig. 1 El. 103.15'

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	Checked by WJB	Date 11/6/72	Sheet No: 7A
For DEERING DAM			

EFFECT OF SURCHARGE STORAGE

Step 5 (cont.)

B. $STOR_4 = \frac{316\ Ac \times [103.15 - 97] \times 12''/FT}{4.5\ S.M. \times 640\ A/SM} = 8.05''$

C. $STOR_{AVG} = \frac{8.15'' + 8.05''}{2} = 8.10''$

D. $Q_{P_5} = 8{,}460\ CFS \times \left[1 - \frac{8.10''}{19}\right] = 4{,}860\ CFS$

EL.103.15'

$STOR_5 = \frac{314\ Ac \times [103.15' - 97'] \times 12''/FT}{4.5\ SM \times 640\ A/SM} = 8.05''$ OK

$Q_{P_5} = 4{,}860\ CFS$ OK

CONCLUSIONS :

1. The test flood discharge ($Q_{P_5} = 4{,}860$ CFS) will overtop the crest by 0.15 feet.

2. The spillway (including stoplog sluiceway set at elev. = 97 Ft) has the capacity of 4600 CFS

3. The spillway has the capacity to pass the 95% of the PMF.

ME 101-374-20M

HNTB

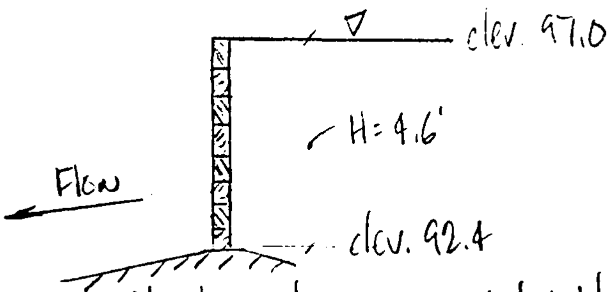
HOWARD NEEDLES TAMMEN & BERGENDOFF

Checked by HM | Date 10/02/78 | Sheet No 8

DEERING DAM

CALCULATION OF GATED CAPACITY @ elev. 97.0

Assume reservoir pool elev. = 97.0 what is capacity of stoplog sluiceway if gate completely opened.



Stoplog sluiceway 5' wide

critical depth will be passed as stoplogs are removed.

For rectangular channels of width b

$Q = 3.087\ b\ H_e^{3/2}$ reference: Std. Handbook for C.E., Merritt

where H_e = spec. energy head, datum = lip of channel
assume negligible velocity head $\therefore H_e = H$

then $Q = 3.087\ b\ H^{3/2} = 3.087 \times 5 \times 4.6^{3/2}$

$Q \doteq 152$ cfs, say 150 cfs

ME101-374-20M

ESTIMATING DOWNSTREAM DAM FAILURE HYDROGRAPHS

METHOD "RULE OF THUMB" IS USED TO ANALYZE THESE EFFECTS

STEP 1: Determine or estimate Reservoir Storage (S) in A-F at time of Failure:

From data on Sheet 1:

Storage at Crest elevation	=	4,984 AF
Plus Surcharge Storage: 314 A × 0.57'	=	179 "
(S) = TOTAL STORAGE	=	5,163 AF

STEP 2: Determine Peak Failure Outflow (Q_{P_1})

$$Q_{P_1} = \frac{8}{27} \times \sqrt{g} \times W_b \times Y_o^{3/2}$$

W_b = Breach width (Use 40% of total Length)
= 0.40 × 650' = 260'

Y_o = Total height from River bed to pool level at failure
= Hydraulic height
= 25.6'

$$Q_{P_1} = 1.68 \times 260' \times [25.6]^{3/2} = \underline{56,580 \text{ CFS}}$$ ✓

STEP 3. Prepare Stage-discharge curve for this section

REACH No 1

REACH DATA:	CHANNEL DATA:
L = 3800'	Shape: Trapezoidal (Apprx.)
S_o = 0.0126 ‰	Bank Slope (L & R) = 9.2:1
n = 0.080	Base Width = 200'

Approximate Location of Section (1) Sta 25+00 ±

STEP 4. Determine the stage for (Q_{P_1}) = 56,580 CFS from fig No 2

a. Stage = 15.8' ± , A = 5,460 [1 AF = 43,560 CF]

Volume within the reach = 3,800' × 5,460$^{\#}$ = 476 A-F

HNTB

HOWARD NEEDLES TAMMEN & BERGENDOFF

HM		9124173	56
Checked by	VP	Date 10/2/73	Sheet No.

For DEERING DAM - PISCATAQUOG RIVER

Since $V_1 < S/2$ (The length of the reach selected is

b. Determine $Q_{P_2(TRIAL)} = Q_p \times \left[1 - \frac{V_1}{S}\right]$

$= 56,580 \times \left[1 - \frac{476\ A}{5,163\ A}\right.$

$= 51,320$ CFS

c. Compute Volume V_2 using the stage pro
by $Q_{P_2(Trial)} = 51,320$
From figure No 2
Stage = 15.1' ±
Area = 5118 #

V_2 = Length x Area $= \frac{3,800' \times 5,118^{\#}}{43,560} = 4$

d Average V_1 & V_2

$V_{AVG} = \frac{V_1 + V_2}{2} = \frac{476 + 446}{2}$ AF = 4

Compute final outflow = $Q_{P_2} = Q_{P_1}\left[1 -\right.$

$Q_{P_2} = 56,580$ CFS $\times \left[1 - \frac{461\ AF}{5,163\ AF}\right] = 5$

REACH No 2 $Q_p = 51,525$ CFS

STEP 3: Prepare Stage - Discharge curve f
section 2, see fig. 2

REACH DATA

CHANNEL DAT

Length (L) = 11,200' ±
Slope (S_o) = 0.0067'/' (weigh.)
Manning's (n) = 0.08

Shape = Symmet. T
Bank Slope Z = 10:
Base width = 43

Approximate Location of Section ② : Sta : 61·

1-374

STEP 4 : Determine the stage for $Q_{P_1} = 51,525$ CFS from Reach No 1.

From fig No 2 :

a. Stage = 12.75'± Area = 7,108 □'

$$V_2 = \frac{11,200' \times 7,108}{43,560 CF/AF} = 1,828 \text{ AF} \quad < S/2 = 2,581.5 AF \text{ OK!}$$

b. Compute $Q_{P_{2(Trial)}} = 51,525 \text{ CFS} \times \left[1 - \frac{1,828}{5,163}\right] = 33,286 \text{ CFS}$

c. From Fig No 2 determine the stage for $Q_{P_2} = 33,286$

Stage = 10.0 → Area = 5,300±

$$V_2 = \frac{11,200' \times 5,300}{43,560 CF/AF} = 1,363 \text{ AF}$$

d. $$V_{Avg.} = \frac{1,828 + 1,363}{2} \text{ AF} = 1,595.5 \text{ AF}$$

$$\therefore Q_{P_2} = 51,525 \times \left[1 - \frac{1,595.5}{5163}\right] \text{CFS} = 35,600 \text{ CFS}$$

REACH No. 3

$Q_{P_1} = 35,600$ CFS

STEP 3. Prepare Stage-Discharge Curve for section No 3. See fig No 2.

REACH DATA	CHANNEL DATA
Length = 3,000'	Shape - Trapezoidal
Slope = 0.033%	Bank slopes Z = 6.9:1
Manning's "n" = 0.08	Base width = 60'

Approximate Section Location ③ Sta. 163+00 ±

HNTB	Made by HM	Date 9/29/78	Job No 5021-11-02
HOWARD NEEDLES TAMMEN & BERGENDOFF	Checked by VHP	Date 10/2/78	Sheet No. 12

For DEERING DAM

STEP 4: Determine the stage for $Q_{P_1} = 35{,}600$ CFS.
From Fig. No 2

a. Stage = 14.9' Area = 2,426 #

$$V_2 = \frac{3{,}000' \times 2{,}426^{\#}}{43{,}560 \text{ CF/AF}} = 167 \text{ A-F} < 5/2 \quad \text{OK!}$$

b. Compute $Q_{P_2 (\text{Trial})} = 35{,}600 \times \left[1 - \frac{167}{5163}\right] \text{CFS} =$
$= 34{,}450$ CFS

c. Determine stage for $Q_{P_2 (\text{Trial})} = 34{,}450$ CFS

Stage = 14.7' A = 2,373 #

$$V_2 = \frac{3{,}000' \times 2{,}373^{\#}}{43{,}560 \text{ CF/AF}} = 163 \text{ AF}$$

d. $V_{AVG} = \frac{167 + 163}{2} \text{ AF} = 165$

$$Q_{P_2} = 35{,}600 \times \left[1 - \frac{165}{5163}\right] = 34{,}460 \text{ CFS}$$

REACH No 4 $Q_{P_1} = 34{,}460$ CFS

STEP 3: Prepare Stage-Discharge curve for section No 4
See Fig. No 2.

REACH DATA

Length = 8,600'
Slope = 0.00285'/'
"n" = 0.06

CHANNEL DATA

Shape = Unsymmt. Trapez.
Bank Slopes:
$Z_{LEFT} = 7.4:1$
$Z_{RIGHT} = 15:1$
Base Width = 430'

STEP 4 Determine the stage for $Q_{P_1} = 34{,}460$ CFS
From Fig. No 2

a. Stage = 10.9' Area 6018 □'

$$V_2 = \frac{3{,}600' \times 6{,}018^{\square'}}{43{,}560} = 1188 \text{ AF} \quad < S/2 \quad \text{OK!}$$

b. Compute $Q_{P_2(TRIAL)} = 34{,}460 \left[1 - \frac{1188}{5163}\right]^{CFS} =$

$= 26{,}530$ CFS

c. Determine stage for $Q_{P_2(Trial)} = 26{,}530$

Stage = 9.5' A = 5100 □

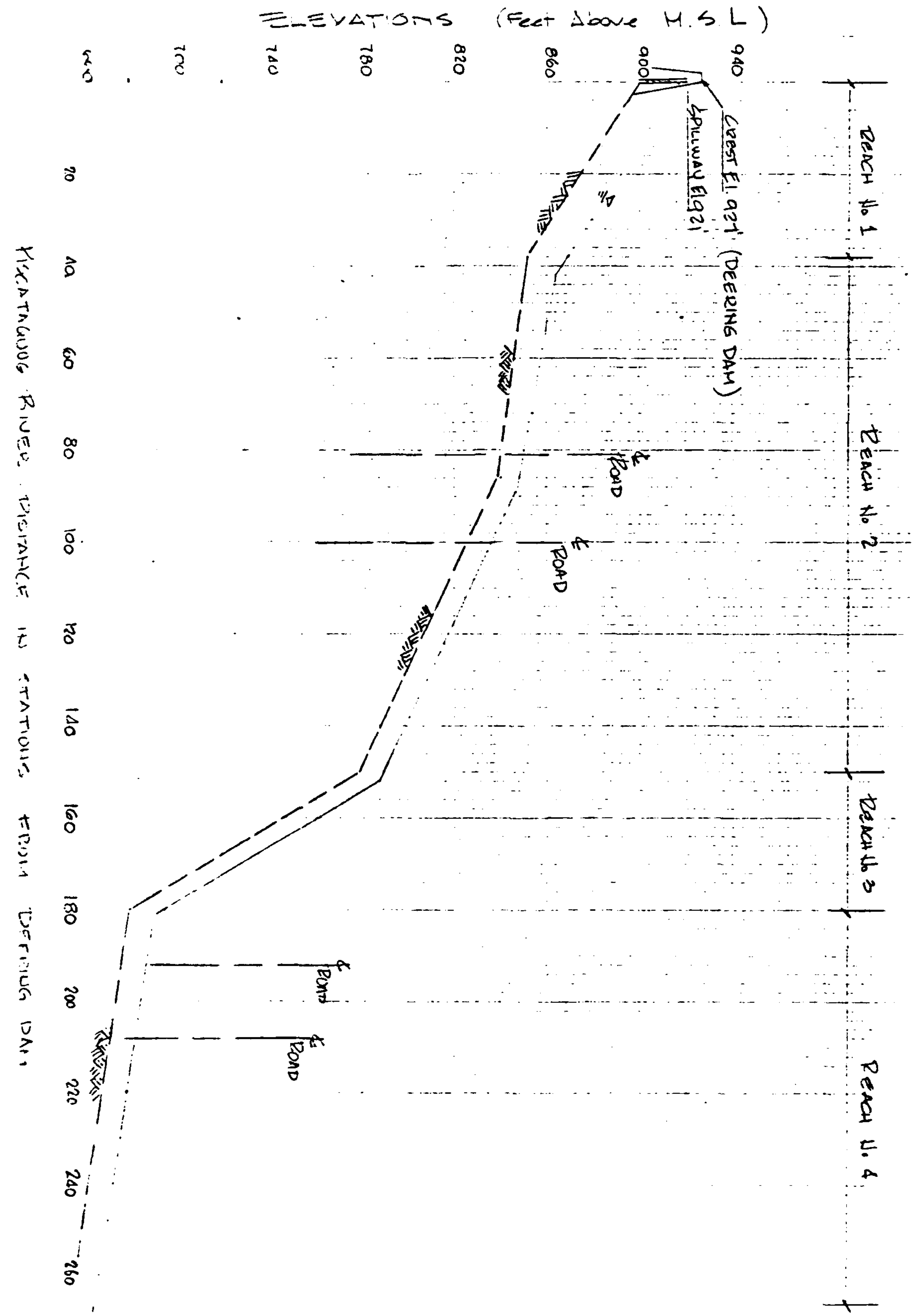
$$V_2 = \frac{8{,}600' \times 5{,}100^{\square}}{43{,}560} = 1006 \text{ AF}$$

d. Calculate $V_{AVG} = \frac{1006 + 1188}{2} \text{ AF} = 1097 \text{ AF}$

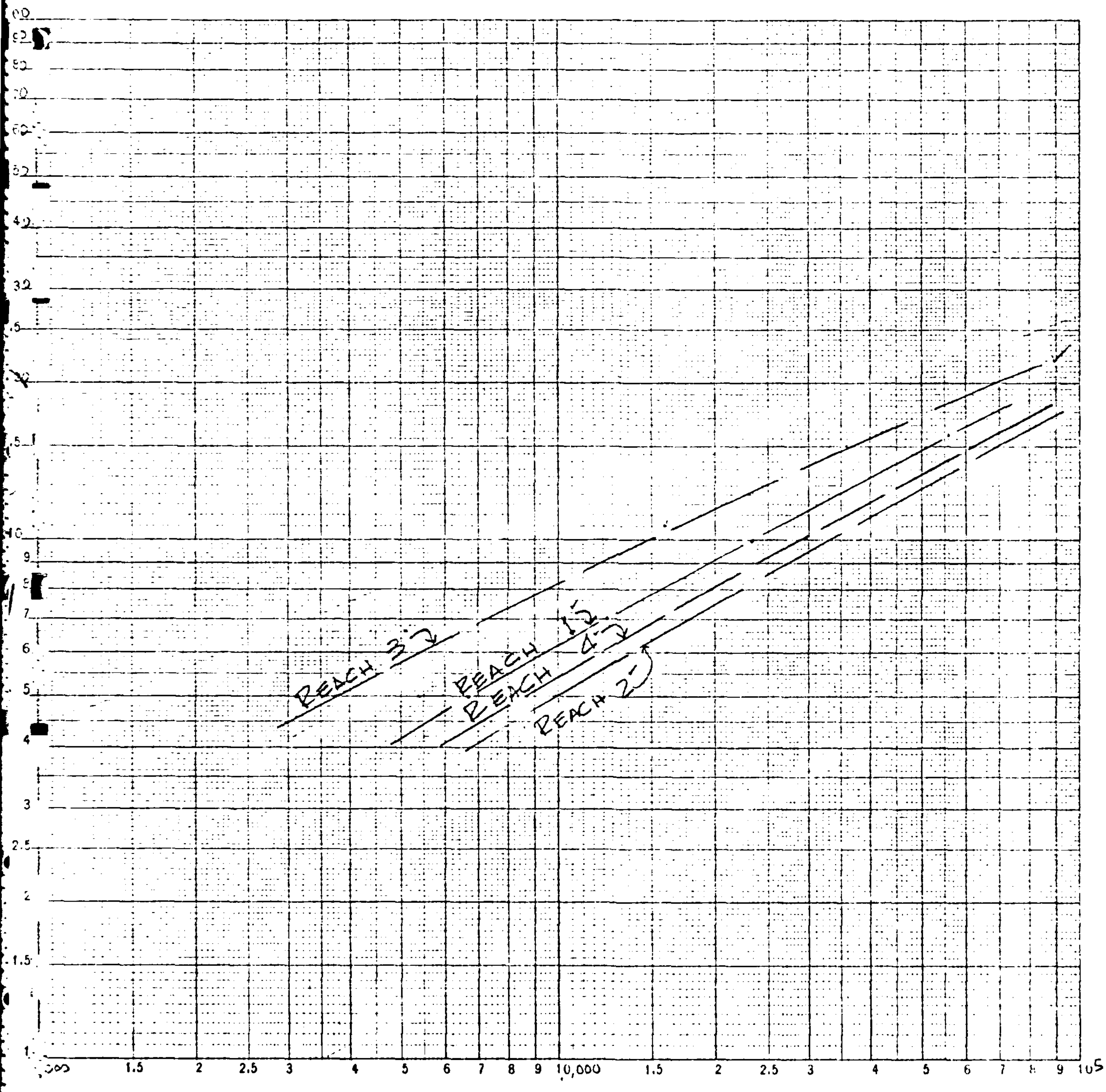
$$Q_{P_2} = 34{,}460 \text{ CFS} \times \left[1 - \frac{1097}{5163}\right] = 27{,}140 \text{ CFS}$$

HNTB HOWARD NEEDLES TAMMEN & BERGENDOFF	Made by	Date	Job No 5323.11-02
	Checked by	Date	Sheet No.

For: WATER PROFILE FOR DAM FAILURE HYDROGRAPHS



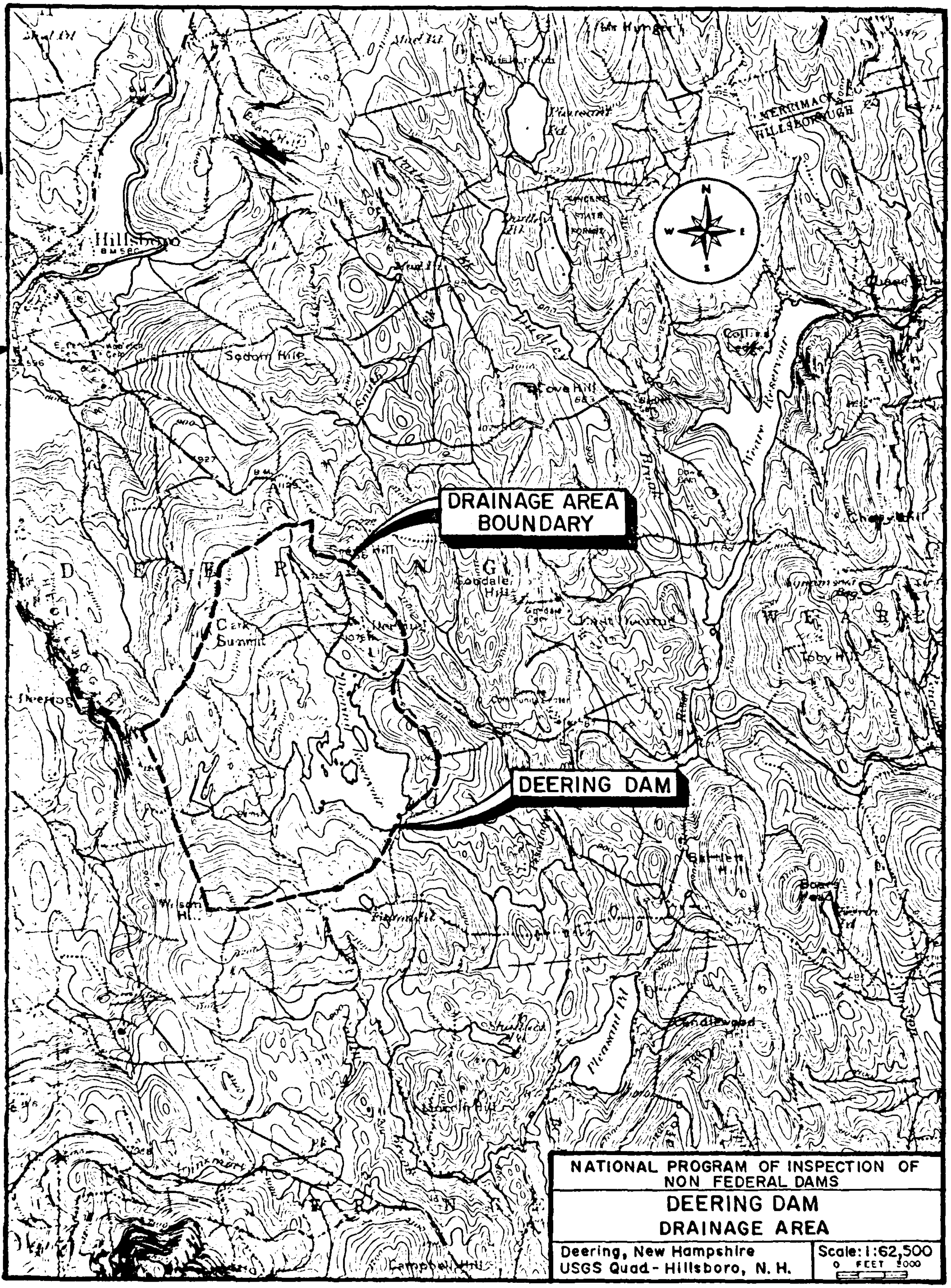
DEERING DAM
RIVER CHANNEL ANALYSIS



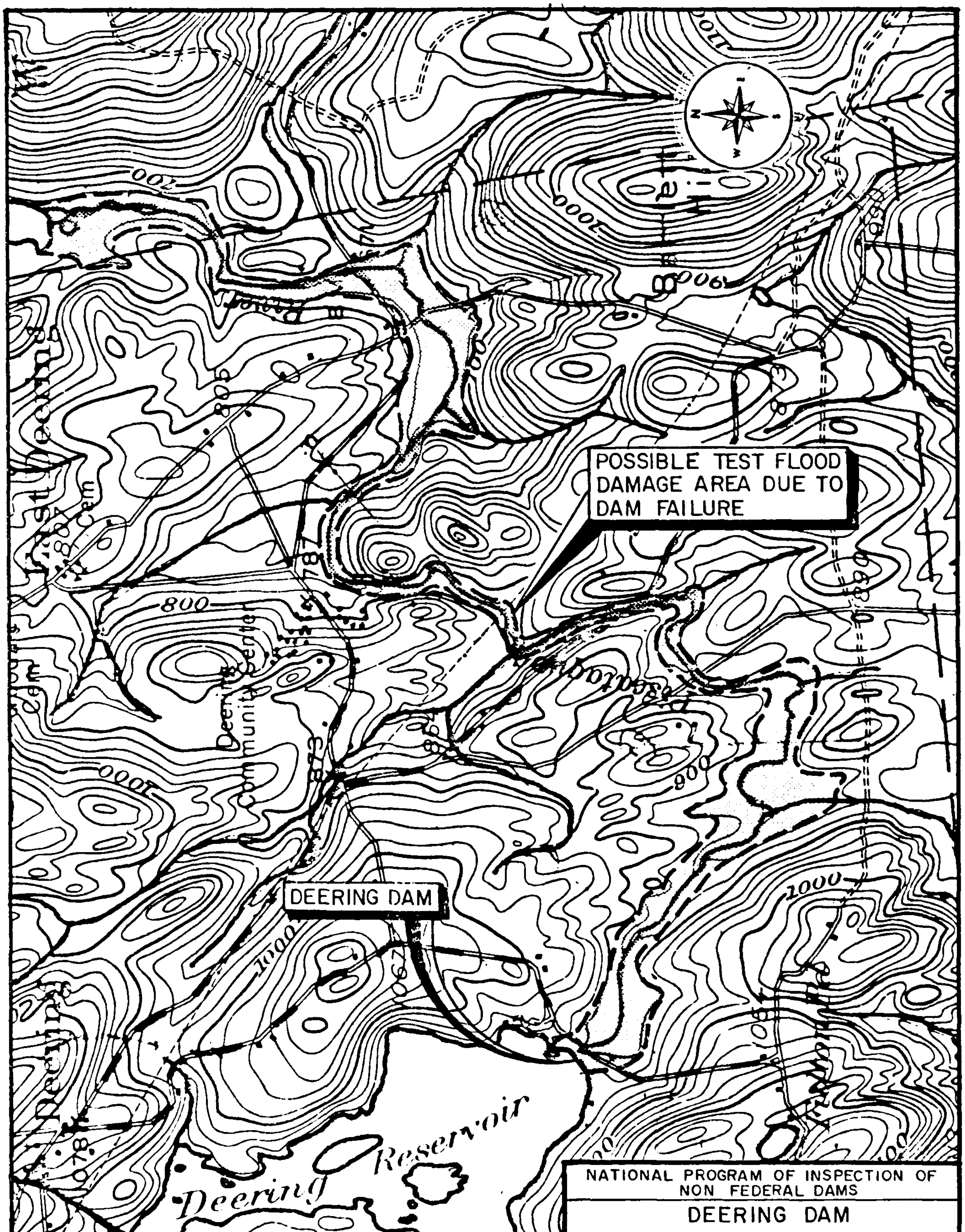
DISCHARGE (C.F.S.)

STAGE-DISCHARGE
CURVES

FIG No 2



DRAINAGE AREA BOUNDARY
DEERING DAM
NATIONAL PROGRAM OF INSPECTION OF NON FEDERAL DAMS
DEERING DAM
DRAINAGE AREA
Deering, New Hampshire
USGS Quad - Hillsboro, N. H.
Scale: 1:62,500
0 FEET 5000



NATIONAL PROGRAM OF INSPECTION OF
NON FEDERAL DAMS

DEERING DAM

TEST FLOOD DAMAGE AREA

Deering, New Hampshire
USGS Quad.-Hillsboro, N.H.

Scale: 1:24,000

APPENDIX E

INFORMATION AS CONTAINED IN

THE NATIONAL INVENTORY OF DAMS

END

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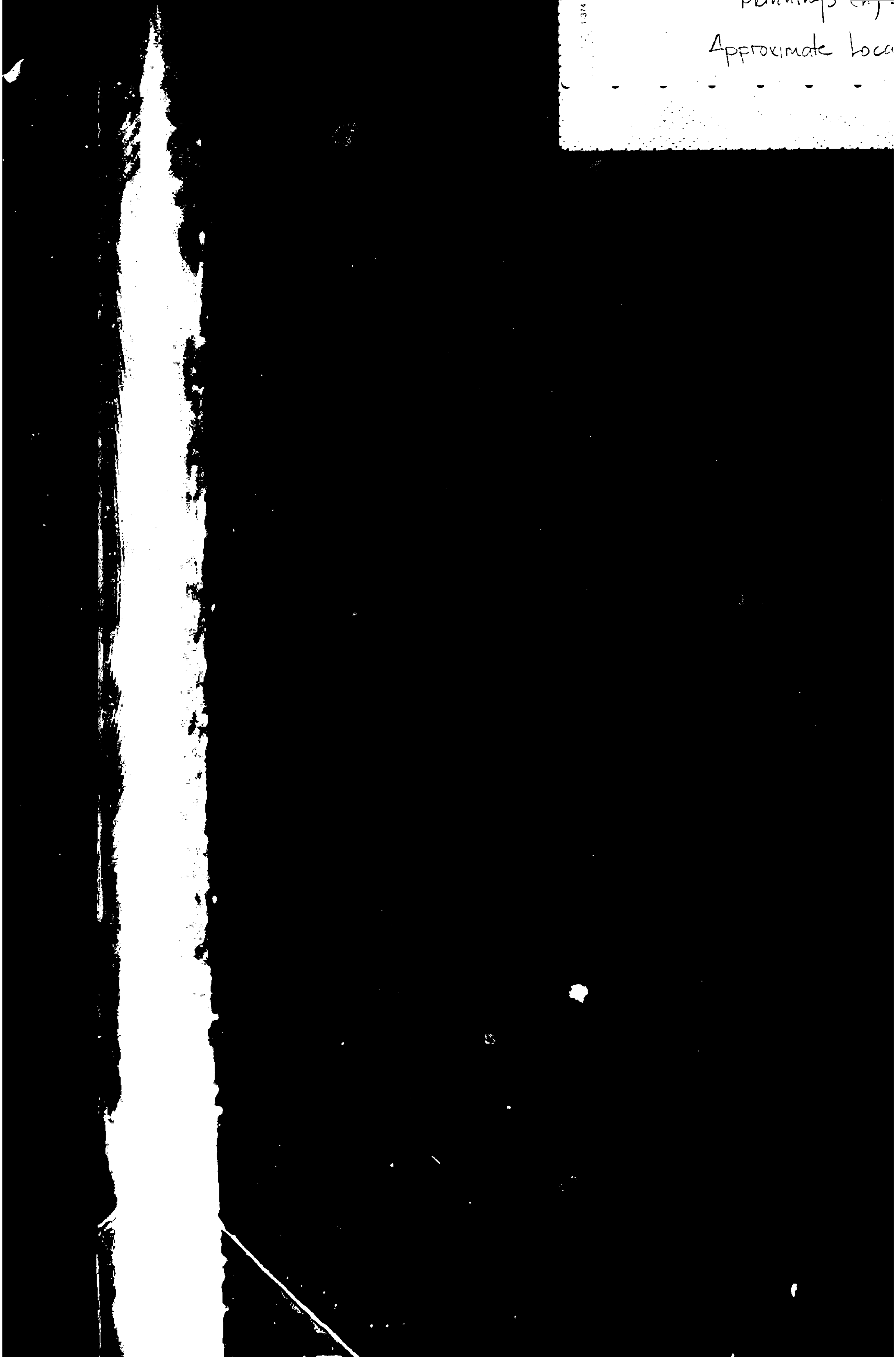
1-374
Approximate Loca